

their dead companion at the bottom ; and if this fury subsided for a time, it was repeatedly renewed without apparent cause, and with an activity which caused them sometimes to leap out of the water, and even over the side of the vessel, to a considerable distance. Mr. Edward surmises that in the open sea this propensity to leap above the surface is rarely exercised ; but it renders it difficult to keep them alive within a narrow space, and in the present instance it became necessary to place a (glass) cover on the vessel in which they were confined—an arrangement which speedily caused the death of two of the remaining combatants, in consequence of the injury they received from leaping against it in the violence of their contention. Mr. Edward remarks that he never witnessed the lifting up of the longer filament in front of the ciliated membrane on the back, but only of such as were behind it. The latter, however, were kept in constant vibratile action when the proper fins were at rest (as is the case also with this membrane in the Rocklings), while on the slightest disturbance their motion ceased and they sank within the protection of the channel prepared to receive them. The single barb in front of the upper lip appears to be endued with some special function, since, unlike the others, it is capable of visible, and perhaps voluntary, extension and retraction.

I regard it as no other than an act of justice to the discoverer of this fish to assign to it the name of Edward's Midge (*Couchia Edwardii*), of which the specific character is sufficiently obvious.

Some Observations on British *Salpæ*. By W. C. McINTOSH,
M.D., F.L.S.

[PLATE I.]

[Read Nov. 16, 1865.]

THE comparative rarity of these swimming Molluscoids within the ordinary experience of British zoologists induced me to pay some attention to them when lately engaged with another department of the science in the Hebrides. Indeed during the month of August they were the grand feature of the Western Ocean ; so that the late Professor E. Forbes, in his three voyages through Scottish seas, during which he states that he saw not a single specimen *, must have passed these islands at the wrong season,

* And Gossé observes, in his 'Manual of Marine Zoology,' vol. ii., "They are chiefly tropical and oceanic animals, swimmers in the wide and open sea, visiting our coast so rarely that we can scarcely reckon them as properly British animals."

or kept too far from shore. Dr. McCulloch, the discoverer of the species described in the 'British Mollusca,' mentions that he found them from the middle to the latter end of August, and always linked together. They occurred lately from the beginning to the end of August; and probably the time of their appearance stretches into the end of July and the beginning of September*. They appear to have a wide distribution on the shores of the Western Islands and the regions bordering on the Minch, northwards and southwards.

At the beginning of August *Salpa runcinata* was the only species met with on the eastern shores of North Uist. The wind was westerly, and the weather good. In the creeks of Lochmaddy the hand-net could scarcely be put in without bringing some individuals of the solitary or aggregate forms to land (figs. 1 to 4). At this time few chains or portions of chains were met with along the beach-line, though the sea was calm. The separation of the aggregate forms must therefore have been due to changes in the individuals themselves or to previous rough weather. These individuals kept a foot or more under the surface of the water, and swam with vigour, showing none of the signs of impaired vitality that might warrant the statement that they soon perish after separation †.

In the loch itself on a quiet evening this species swarmed, moving in longer or shorter chains a few feet from the surface. Some of the chains had only a very slight bend; others were curved at one end like a crook; while a third series almost formed a U. There was no coiling or uncoiling of the chains, so far as I saw; but they moved slowly and steadily along, each appearing like a milky, semitranslucent, gelatinous riband marked with a series of dots. The most common hue of the visceral speck is brownish orange, though in some of the smaller individuals it is slightly yellow. Many solitary animals were also caught, and in confinement they proved somewhat hardier than the individuals of the aggregate form. Dr. McCulloch observes of this species, "that, like the Medusæ and analogous tribes, it cannot bear to be confined in a limited portion of water, as it died, even in the ship's bucket, in less than half an hour—a very remarkable circumstance in the economy of these imperfect animals." No difficulty, however, was encountered in this case in keeping Salpæ of all the forms

* Dr. Fleming got *S. runcinata* in spring on the coast of Caithness.

† *Vide* Rymer Jones's 'Animal Kingdom,' *Salpæ*.

alive for several days, provided the vessel was clean, wide at the top, and the sea-water frequently renovated.

No large Medusæ occurred in the bay at this date, the only other oceanic swimmers being hosts of a little *Sarsia* and a *Thaumantias*, that were caught in the creeks.

The Salpæ seem to be very sensitive in regard to the weather, as indeed the fragility of their chains might indicate. None appeared for about a week of rough or rainy weather, even though the surface of the sea might be as smooth as glass but for the pattering of the rain-drops. On a somewhat rough day the dredge near the mouth of the loch brought up in its progress hosts of the little *Thaumantias* previously mentioned, but not a single *Salpa*; so that they must have entirely evacuated the bay. Towards the eighth day a few isolated individuals were met with, not in the best condition; those amongst the rocks were mostly withered ones floated off the blades of *Fuci* between tide-marks. About a fortnight afterwards many of the same species (*S. runcinata*) were got near the mouth of the bay; but, curiously enough, all were brought in by the dredge, not a single specimen being captured by the towing-net, although the sea was moderately calm. Two other forms, however, were abundant on the surface, viz. *Salpa spinosa* of Otto (figured and described by Sars*, and mentioned by Forbes and Hanley in their work) and its progeny in chains (figs. 5 to 9). None but battered specimens of *S. runcinata* appeared at this time near the shore.

The enormous numbers of the two forms of *S. spinosa* that were driven into the creeks next day by the easterly breeze were surprising, and showed the extraordinary fecundity of the genus. The hand could not be held amongst the mild sea-water that laved the littoral *Fuci* without coming into contact with chains of the one form and individuals of both, that every wave of the sea poured in to be destroyed. After the breeze moderated, the *Fuci* between tide-marks sparkled in all directions with the quivering bodies of the unfortunate Salpæ, that, besides, here and there lay in heaps where the ebbing tide had stranded them behind stones. The hand net was filled by a solid mass when plunged into the water, and only a few specimens of *S. runcinata* were found amongst them.

* 'Fauna littoralis Norvegiæ,' part i. p. 79, tab. 10. This work did not come into my hands before the present paper had left them. The differences in the figures and descriptions will explain themselves; they are chiefly confined to the former.

So plentiful were the beached Salpæ that the Fuci were rendered doubly slippery, and the tangled masses of *F. serratus* hung down from the rocks their every crevice spangled with the glittering mollusks. The small fishes (Coalfishes, Fifteen-spined Sticklebacks, Gobies, and young Wrasses) were in unusual numbers at the sea-border, hunting about in shoals, and doubtless feasting luxuriantly on the autumnal repast so plentifully cast in their way. Nor were other marine animals behind in this respect: one Caryophyllia that hung from a stone at the verge of low water attracted notice by having its disk unusually expanded and translucent, hard to the touch, and not contracting by the latter stimulus or exposure to the air; the cause of all this was found to be the presence of at least eight of the unfortunate Salpæ in its stomach, some of them still free from serious injury. Salpæ do not occur in such profusion at all seasons, and the change of diet is doubtless agreeable to the marine inhabitants of these shores.

The climax of Salpa life, however, was reached on the 22nd of August, when the sea was unusually calm and the weather very fine. The shores of the creeks and bays were so heaped with the bodies of the two forms of *S. spinosa* that the Fuci and rocks appeared as if coated with masses of boiled sago; the water of the creeks resembled starch from the myriad swarms; and the Laminarian blades at low-water mark lay on a semisolid medium. There were vast multitudes, certainly, on and near the beach; but a sail in the bay demonstrated a still more wonderful extent of Salpa prolificness. It may be safely said that there was not a single square foot of Lochmaddy that did not contain Salpæ, and in some parts the sea resembled boiled sago for long distances. On the surface floated the two smaller forms of *S. spinosa*, the aggregate, as usual, predominating over the solitary ones; while from a few feet under the latter, as far down as the eye could reach, chains of all lengths and sizes of *S. runcinata* swam with the current in the quiet manner previously described. These milky bands crossed and recrossed each other to such an extent that the very character of the sea, I may say, was altered; and it seemed as if flocculent strings of some milky precipitate hung therein, or as if gigantic fibres of asbestos had been scattered in profusion and at random throughout the entire bay. The scene was equally novel and interesting. With every stroke of the oars the purple and two-horned forms (*S. spinosa*) rose from the water and rolled like glassy crystals from the blades, and chains of the former now and then clung till a reimmersion washed them off.

The very progress of the boat appeared to be impeded; and on looking along the still expanse of the sea, their quivering bodies roughened its surface like a myriad tremors on molten glass.

Towards the mouth of the bay, drifted masses of Fuci formed long transverse lines across the surface, and at these parts not only were the Salpa-masses increased in density, but a number of other swimming jellies of a different subkingdom accompanied them, such as *Pelagia cyanella*, *Æquorea*, *Oceania*, *Beroë*, and *Diphyes*, the cavities of the two former containing many Salpæ. Some small fishes also skimmed the surface, apparently feeding on the latter; and with the hand net young Sand-launces, Brills, and numerous Mackerel Midges (*Motella (Couchia) glauca*) were captured. In such circumstances there was no need of a towing-net; and indeed it was practically useless, becoming filled in a few seconds with a solid mass of the surface forms. Numerous gulls and guillemots that had been at work at these seaweed lines amongst the Salpa-hordes, or seizing the small fishes so engaged, took wing on the approach of the boat. The Salpæ extended outwards into the Minch in almost as great numbers. The sea was so calm that the Dunvegan packet had to be towed by its own boat from Skye to Lochmaddy—not a very common occurrence in these wild waters.

At this time not a scrap of a Salpa or a Medusa was found at the western side of the island; so that the Salpæ must have passed through the Sound of Harris with the westerly winds in the beginning of August, or else were originally resident in the Minch, and had been driven westwards by the easterly gales.

The chains of *Salpa runcinata* in sight varied from two and a half yards downwards; and the deeper ones may have been longer. Those near the surface were generally less than a yard long. As before mentioned, there was neither coiling nor uncoiling, nor the "regular serpentine movements" described in the various text-books; but the bands moved slowly through the water, seldom altering their curves to any appreciable extent. They varied in bulk according to the size of the component individuals. The mode in which they were attached to each other in these chains was not so easily made out as at first sight might appear; they separated into pieces when lifted from the water either with hand or net; and there is thus good excuse for the rude outline of Dr. McCulloch—an outline, however, that will at once be recognized by any one who has seen them in their native haunts. The figure by the late Professor E. Forbes*,

* Brit. Mollusca, vol. i. pl. E. fig. 6.

showing two in apposition, is stiff and artificial—a state in which it would never have been represented if he had seen living specimens.

The individuals adhere to each other by a considerable extent of their edges, including the attenuated extremities, and form a sort of interrupted double row by being alternately attached. Thus, for instance, the second is attached to the first on its *right side*, the point of its attenuated process reaching beyond the visceral speck. The third adheres to the *left side* of the second, its point also proceeding beyond the nucleus. The long axis of each is nearly parallel to that of the entire chain. Dr. McCulloch states that “each individual adheres to the preceding by a regular sequence of superposition lengthwise, so that the whole form a long simple chain.” He must have viewed the riband laterally.

Sometimes two individuals of large size (each 3 inches long) swam together—the fragment of a chain; and numerous single ones of the aggregate as well as of the solitary form occurred. The proper sphere of this species seemed to be from a point some feet below the surface, downwards, since any met with at the surface were mutilated, dying, or dead. One individual of the aggregate form was caught, just beyond the rocks, with a young specimen (true embryo of Professor Huxley) in its interior (fig. 1). The embryo, *a*, adheres to the nucleus, *b*, of the parent by the posterior extremity, and thus its anterior orifice agrees with that of the adult—a situation affording every facility for the passage of constantly renewed currents of water through its cavity. The adult specimen in this case exhibits a very common anastomosis of the muscular bands. In life these bands are scarcely seen, except as slight wrinkles during contraction; it is the immersion into strong spirit that renders them so visible.

The youngest condition of the solitary form observed is probably represented by that in the interior of fig. 1; the next, in the free form shown in fig. 4, where the preponderance of the visceral over the locomotive apparatus is very apparent. This is exactly the reverse of what takes place in the Ascidians, whose young forms acquire the maximum locomotive, the adult the maximum visceral. Each has its various requirements amply supplied in the structures developed at the time. The rounded opaque body *a*, fig. 4, would seem to be embryonic, since it diminishes progressively as the size of the animal increases, and in the adult disappears. In fig. 2 a developing chain is observed at *f*. A peculiar network of vessels occurs over a limited space in two of the solitary forms figured (*b*, figs. 2 and 3).

The solitary form of *S. spinosa* is very transparent, and during life its six circular muscular bundles are also only seen as faint lines during contraction. In addition to the characteristic posterior spines, there is a stout bifid spinous process (*g*, figs 5 & 6) and a small lateral spine on each side of the coiled chain. A small red ocellus is seen at *a*, fig. 5, and four opaque dots at *b*. The branchiæ, endostyle, nucleus, and coiled chain with various grades of developing young are represented in the figures. After preservation in spirit the inner tunic is seen to end, in each of the long posterior spines, in a trumpet-shaped process. This appearance is also observed in figs. 7 and 8, which represent a front and lateral view of a small and very active individual captured with the towing-net. It is probably a developing specimen of this form, judging from the number of muscular bundles and the trumpet-shaped ending of the tunic in the posterior processes. The latter, however, are flattened, oar-shaped, and short. It also possessed the bifid spinous process, at *b*, fig. 7. The nucleus was of a dull white hue in life; and the embryonic body, *a*, was still present. In one case the adult solitary form of this species was dead, as likewise were the included young; but the individuals (measuring $\frac{1}{10}$ th of an inch long) of the pigmy chain depending from the parent contracted vigorously. Each was furnished with a little red ocellus.

The individuals of the aggregate form of *S. spinosa* were of all sizes, from $\frac{3}{4}$ of an inch in diameter downwards. Their figure was somewhat pyriform and faceted (fig. 9). The nucleus is tinted of a fine bluish purple with a streak of yellow, and the branchial apparatus has also the former hue. At the anterior end of the nucleus a constant ciliary motion was seen under the lens, not connected with the efferent current issuing at the posterior aperture. When adhering together in chains, they swim with the bluish-purple nucleus downwards; and the same remarks apply to their mode of locomotion as to the ribands of *S. runcinata*. The chains of the former were in general much shorter than those of the latter, though broader in proportion, since they were composed of a double row with the individuals arranged alternately; that is, the transverse fissures of the one row were opposite the centres of the other.

When swimming in a vessel during the day, the contractions of *Salpa spinosa* and its aberrant form caused a lens-like condensation of the rays of light, which flashed on the glass beneath them on each occasion. *S. runcinata* was not observed to be lu-

minous in the twilight in the sea, neither were the two forms of *S. spinosa*; but when the latter were enclosed in a bottle, bright-greenish phosphorescent sparks were emitted on jarring the vessel in the dark; this, however, may have been due to the presence of other minute oceanic forms. There was no luminous appearance when the vessel was left quiescent in the dark; and none of the forms of either species were observed to give out the bright-greenish phosphorescence that invariably gilded the luminous Medusæ and Annelids for a few seconds after immersion in spirit.

A curious appearance was caused on the beach, during the plenitude of Salpa life, by the occurrence of two days of fine weather. The dried bodies of the beached Salpæ left whitish, glistening, scale-like patches on the black gneiss-stones and bare rocks near high-water mark; and when the chains of *S. spinosa* happened to subside without separation, an appearance was produced like the frond of *Asplenium viride* or *Trichomanes*, or the fossil imprint of some primeval fern.

DESCRIPTION OF PLATE I.

[Figs. 1, 2, 3, 6, 7 and 8 are from carefully made spirit preparations.]

- Fig. 1. *Salpa runcinata*, with young solitary form (true embryo of Huxley) in its interior. Enlarged. *a*, the embryo; *b*, the nucleus of the adult; *c*, the branchiæ; *d*, the endostyle.
- Fig. 2. An adult solitary form of the same species, about the natural size. *a*, nucleus; *b*, peculiar network of vessels; *c*, branchiæ; *f*, developing chain of young; *h*, endostyle.
- Fig. 3. A lateral view of another, smaller solitary form, showing the embryonic body at *a*, and the network of vessels at *b*. Enlarged.
- Fig. 4. A very young solitary form of *S. runcinata*. *a*, large embryonic body; *b*, nucleus; *c*, intestine. The muscular bands, branchiæ, and endostyle are apparent.
- Fig. 5. *Salpa spinosa*, enlarged, from a living specimen. *a*, ocellus; *b*, four minute opaque dots; *c*, branchiæ; *d*, nucleus; *e*, inner tunic with its muscular bands; *f*, coiled chain of young; *g*, bifid spinous process; *h*, endostyle.
- Fig. 6. A lateral view of one of the same species, enlarged.
- Fig. 7. Young solitary form of *Salpa spinosa* (?), enlarged. *a*, embryonic body; *b*, bifid spinous process; *c*, trumpet-shaped ending of inner tunic (mantle) in the posterior spine; *d*, nucleus.
- Fig. 8. A lateral view of the same specimen. The letters are similarly placed.
- Fig. 9. The aggregate form of *S. spinosa*, enlarged, from a somewhat contracted living specimen. *a*, bluish-purple nucleus; *c*, branchiæ; *h*, endostyle.

